National Park Service
U.S. Department of the Interior

Southeast Utah National Parks & Monuments

Canyon Country Outdoor Education
Sixth Grade Curriculum

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Sixth Grade Curriculum

National Park Service
Utah

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Contents

Students search for birds during the "Heat, Light and Sound" field trip.


NATIONAL PARK SERVICE


HARRIS PORTER

FIELD TRIP
Microorganisms

Theme
Microorganisms play a vital role in the high desert ecosystem. They are everywhere!

Utah State Science Core Curriculum Topic
Standard Five: Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective One: Observe and summarize information about microorganisms.

Objective Two: Demonstrate the skills needed to plan and conduct an experiment to determine a microorganism's requirements in a specific environment.

Objective Three: Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

Field Trip Location
Accessible pothole locations include Sand Flats Recreation Area east of Moab and Pothole Point in the Needles District of Canyonlands. Potholes are ephemeral and dynamic, so don't count on a full pothole unless you've visited it very recently. Activity in potholes is greater when the water is warmer, from late spring through fall. Lichens are found almost everywhere there is rock; you'll need south-facing and north-facing rock slopes for the investigation. Cryptobiotic soil is extensive in southeastern Utah; a place with crypto islands in slickrock is most easily examined without damaging the soil.

Times
Pre trip is 30 minutes
Field trip lessons are each one hour
Post trip is 45 minutes

Science Language Students Should Use
Algae, fungi, microorganism, decomposer, single–celled, organism, bacteria, protozoan, producer, hypothesis, experiment, investigation, variable, control, culture

Background

Microorganisms are everywhere and play many important roles in the high desert ecosystem. Some microorganisms are plants or animals, but some belong to the other three kingdoms of living things. Some sixth-grade students may be familiar with the kingdoms and may ask about them, so here's an update or review. 1) *Monera* consists of bacteria, including cyanobacteria. Monerans are small, simple, single cells, and sometimes form chains or mats. Some absorb food; some are photosynthetic. 2) *Protista* includes protozoans and algae of various types. These are large, complex, single cells, sometimes forming chains or colonies. They get their nutrition in a variety of ways. 3) *Fungi* are molds and mushrooms. These have a multicellular filamentous form with specialized complex cells. They absorb food. 4) *Plantae* are plants, including mosses, ferns, woody plants, and non-woody plants. These are multicellular forms with specialized complex cells; they photosynthesize. 5) *Animalia* includes everything from sponges and worms to mammals. Animals are multicellular forms with specialized complex cells. They ingest food. Viruses aren't included in the kingdoms because

Studying pothole organisms

they are on the borderline between living and non-living things. They are noncellular parasites that cannot live or reproduce outside of a living organism.

Probably, the most fragile component of this arid region is cryptobiotic soil crust. The crust is a community of microorganisms, including cyanobacteria and a variable mix of lichens, fungi, and mosses. This network of organisms plays a vital role in erosion control, nitrogen fixing, and moisture absorption. One footprint can destroy years or even decades of this soil's growth, and new growth often has a different mix of organisms than that of the previous crust.

Rock lichen is composed of another community of microorganisms, namely fungi, with algae, cyanobacteria, or both. That's two or three kingdoms intermeshed. Fungus forms the tough outer layers of lichen, while algal (and/or cyanobacterial) cells enmeshed in fungal threads compose the inner layers. The lichen structure is more elaborate and durable than either fungi or algae alone. Dry lichens have the ability to absorb more than their own weight of water. They can carry on food production at any temperature above 32°F. Temporary water, such as dew, can be taken almost directly into the algal cells of the lichen; the water does not need to go through roots and stems as it does in vascular plants.

Desert potholes provide homes to a fascinating array of small organisms and microorganisms. Pothole dwellers have unique adaptations, enabling them to survive in this feast or famine environment. Most of these organisms have shortened life cycles, reducing the length of time they are dependent on water, and thus allowing them to live in shallow, short-lived pools. The life cycles of clam shrimp and fairy shrimp are 5-10 days. The life cycle of a tadpole shrimp is 12-14 days. Tadpole shrimp, as a result, require deeper potholes in order to survive.

A pothole's size determines its diversity and species make-up. Microorganisms, such as single-celled algae and protozoans, inhabit shallower pools. Slightly deeper pools might have tiny worm-like larvae of midges wriggling around their bottoms. The deepest and largest pools might contain a variety of tiny crustaceans and insects: fairy shrimp, clam shrimp, tadpole shrimp, water striders, back swimmers, water boatmen, and whirligig beetles.

A pothole is a unique habitat that is very easily disturbed. Pothole organisms are sensitive to sudden water chemistry changes (brought on by sunscreen, for example), temperature changes, sediment input, being squashed, and being splashed out onto dry land.

Seedling in cryptobiotic soil crust

PRE-TRIP ACTIVITY

Mystery Photographs

Objectives

Students will be able to:

a. Define the term microorganism.

b. Name at least two kinds of microorganisms and their functions.

Materials

Six copies of a numbered set of photographs of microorganisms (*from* Kuhn, 1988: 30-33; Nardo, 1991: 39, 60, 63; Ricciuti, 1994: 11, 47); seven copies of *Mystery Photographs Description Sheet*; optional: books with color photographs of microorganisms.

PROCEDURE

1) Ask students to define the term *microorganism*. Probe them for how much they know about microorganisms. Be sure they know the basic definition of a microorganism: An individual organism that cannot be seen without the aid of a microscope.

2) Break students into six groups. Have each group number a sheet of paper from one to thirteen. Each group will get a set of numbered photographs of microorganisms taken through microscopes. They will also get a sheet with a description of the organisms in the photographs. However, the descriptions are not in the same order as the numbered photos. Their job, as a group, is to match the descriptions to the photographs. Tell students to read the descriptions closely for clues and to write each organism's name next to its photo number. Model one example on the board; illustrate that the first one that they figure out will probably not go on the first line on their paper. Circulate among the groups as they work. If available, hand out books with color photographs of microorganisms to groups that finish early.

3) Reconvene the students as a whole group. Go over the answers, re-reading and discussing just the descriptions that students found difficult to match.

4) Preview the field trip, telling students that they will be looking at a couple of different, small communities of organisms, using hand lenses and microscopes to get close-up looks, and completing some scientific experiments. Review the items that students need to bring to school on the day of their field trip.

Studying microorganisms through a microscope

MYSTERY PHOTOGRAPHS DESCRIPTION SHEET

Because the foot-shaped **paramecium** is transparent, you can see its dark nucleus. The paramecium filters smaller protozoans and bacteria from the water to eat.

Spyrogyra are algae that form floating green masses on ponds. Their spiraling green bands of chloroplasts are the sites where photosynthesis takes place.

Desmids are one-celled green algae that can look like stars, balls, rods, ovals, or figure eights. In great numbers, they may tint the water green.

Shrimp and lobsters have a microscopic relative called a **water flea,** a roundish animal with a small head and feathery antennae**.** The antennae allow the water flea to swim jerkily through pond or pothole water.

Hydras are almost-microscopic animals that look like squids or octopuses. Their tentacles have stinging cells to paralyze prey such as water fleas.

An armored amoeba called a **foraminiferan** makes a multi-chambered shell that drops to the sea bottom after it dies. Where these animals are abundant their shells form chalky limestone layers. The pyramids of Egypt are made of cut blocks of limestone made up of these foraminiferan shells.

The hairy **pneumonia bacteria** pictured here is starting to divide in half.

Proteus mirabilis bacteria is normally present in your intestines, where it feeds on nutrients. It looks like a hairy hotdog.

Yeasts are a type of microscopic fungus. Some of them are used for making bread and pizza dough. Magnified 40,000 times, this one looks a bit like a pizza itself.

Fungi and bacteria are decomposers at work on some dead plant roots in this microscopic view. Look for something that looks like plant roots.

This could be an enlarged view of the leftovers from your last visit to the dentist. (Haven't been lately? Then they're probably still in your mouth!) These **bacteria in dental plaque** are shaped like short and long worms.

The threads holding these sand grains together are actually sheaths of **cyanobacteria,** the main organism in cryptobiotic soil crusts.

Amoebas are one-celled protozoans that move by changing shape and pushing out pseudopods (false feet) in whatever direction they want to go.

STATION ONE
Life in a Pothole

Objectives
Students will be able to:
a. Identify at least three species of animals in a pothole.
b. Explain at least one reason why diversity is beneficial to a pothole ecosystem.

Materials
Dip nets; trays; hand lenses; microscope and slides; Pond Life (Reid 1967); *Pothole Organisms* identification sheets; *Life in a Pothole Data Sheet*; clipboard; calculators.

PROCEDURE

1) Give a 5- to 10-minute pothole introduction to two pothole groups. Avoid making it any longer; much can be covered during observation time. Topics to cover during the station should include: (1) *habitat limitations* in pothole communities, such as drying up, temperature extremes, and water chemistry variations; (2) *adaptations,* especially short life cycles and how organisms survive dry periods; (3) *types of organisms* students may see, including insects (especially larvae), which mostly spread by adults laying eggs in pools, and crustaceans (related to shrimp and lobsters), which mostly survive as eggs in sand/mud during dry periods. You may also discuss micro versus macro organisms; (4) *pothole formation process,* or simply mention that these depressions are rare in the world, but common in the Navajo Sandstone. **Stress the expectations** of students while they are observing the potholes (i.e. where they may stand, not getting into potholes, and how to catch and release organisms).

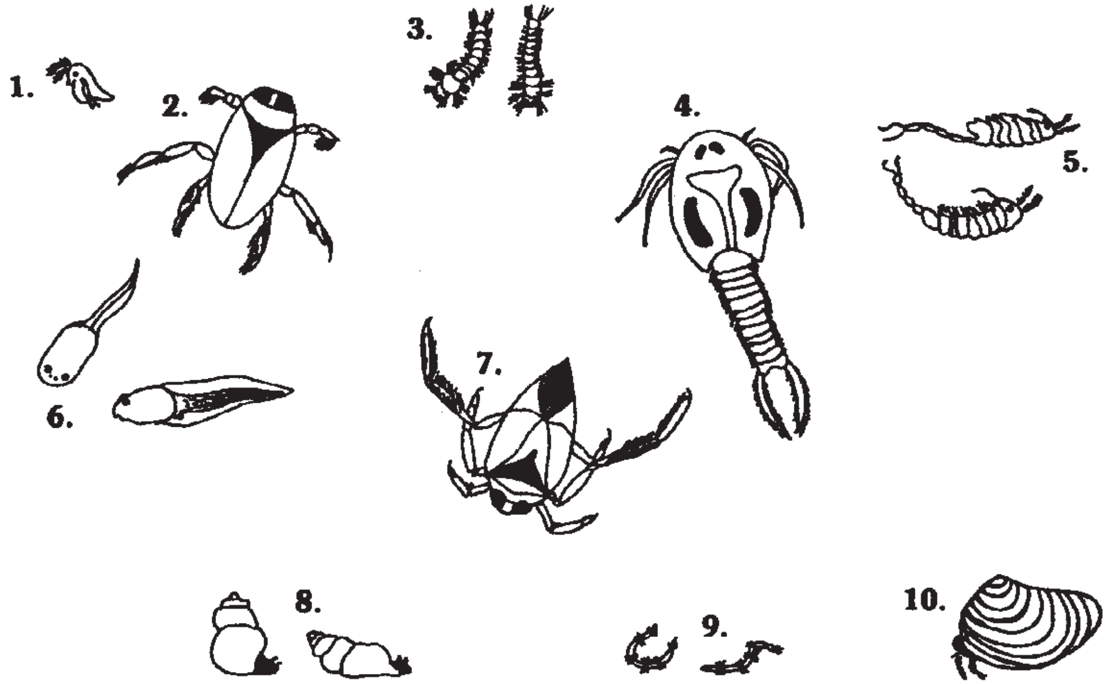
2) Separate into two groups, and go to two different potholes. Help students while they observe and catch pothole organisms. Caught organisms should be placed in a tray for closer observation with hand lenses. Try to catch a smaller organism, and mount it on a slide under the microscope. Once students look, they often become interested in the smaller organisms. Encourage students to use identification sheets. Review main organisms so students learn their names.

3) This step takes 10-15 minutes. Gather students, and discuss *diversity*, first in a general sense and then in a biological one. Tell students that biological diversity is usually measured by the number of species present. Have students name the species found in the pothole they just viewed, and list them on a laminated sheet. Explain that students will be using a *diversity index* to determine how rich the pothole is. To calculate the index, they will need to estimate the total number of individuals of each species. Explain how they might do that in the pothole, and give them a few minutes to come up with estimates. Show students the diversity index formula, and hand calculators to two volunteer students as you go through its calculation with the entire group. Discuss how the index might be used to compare the diversity of different potholes.

4) If the potholes are diverse, just save about 5 minutes to observe the second pothole and make a qualitative comparison with the first. (In this case, have the dip nets put away for the second pothole.) If the potholes are not diverse, have the two groups split the time more evenly between potholes, and calculate diversity indexes for both. (Collect a sample of pothole water for post-trip activity.)

Tadpole shrimp

POTHOLE ORGANISMS



AUDREY GRAHAM

1. Water Flea

2. Water Boatman

3. Mosquito Larvae

4. Tadpole Shrimp

5. Fairy Shrimp

6. Red-spotted toad tadpoles

7. Backswimmer

8. Snails

9. Gnat larvae

10. Clam Shrimp

See also Williams 2000, 172-173.

DATA SHEET

Life in a Pothole

Species Name	**Number of Individuals**
#1	
#2	
#3	
#4	
#5	
#6	
#7	
#8	
#9	
#10	

Total number of Species = **Total number of Individuals =**

Diversity = Total number of species / Square root of total number of individuals =

STATION #2

Lichens Up Close

Objectives

Students will be able to:

a. Identify rock lichens and name two lichen components.

b. Name one role of lichens in the high desert ecosystem.

c. Explain the basic steps of the scientific process.

Materials

Hand lenses; name tags (*algae; fungus; water and minerals; sunlight; oxygen; carbon dioxide; photosynthesis*); pictures of lichens (e.g. Sharnoff, 1997, 58-71; Corbridge and Weber 1998); microscope and slides; quarter sheets of blank paper for observations; copies of *Science Investigation Form* and *Data Collection Sheet: Do Lichens Like Sun or Shade?* (back to back); cardboard plot frames; pencils; clipboards; measuring tapes; compass.

Note

If possible, prepare a lichen slide for the microscope before the station begins.

PROCEDURE

1) Start by briefly pointing out both lichens and mosses on nearby rocks. Make sure that the students can distinguish between them. Then have students sit in a group. Tell them that a lichen is made up of two organisms, and ask if they know or can guess what these are. If a student answers *fungus* or *algae*, have her stand up and put on the corresponding nametag. Prompt as needed. Then, ask students to name something that plants need. As they answer, hand out corresponding name tags, and explain that the fungus attaches to the rock and brings in most of the water and minerals. Have the person with the *water and minerals* nametag stand next to the fungus. Have the people with the *carbon dioxide* and *sunlight* nametags stand around the *algae*. Explain that algae is the only organism of the two that can photosynthesize (make food from these ingredients). Because algae gives off oxygen during photosynthesis, have the person with the *oxygen* nametag point *away* from *algae*. Give the *photosynthesis* tag to the last student, or have *algae* hold it. Re-emphasize that the algae makes most of the lichen's food. Mention, however, that fungus attaches to rock, bringing in much of the water and minerals necessary for making food. An amusing review, that students will remember, goes something like this: "Allen Algae and Frieda Fungus took a lichen to each other. After they married, Allen did the cooking, and Frieda built the house. But, I hear that their marriage is on the rocks."

2) (Note: You may choose to reverse the order of 2 and 3.) Tell students that they will be using hand lenses and microscopes to examine the area's lichen. Ask each student to write down two observations he/she makes with the hand lenses and two observations he/she makes with the microscope. Give boundaries, and hand out hand lenses. Have half the group start with the microscopes and half with the hand lenses. Afterwards, have students sit back down and take turns reading at least one observation each.

3) Show students lichen photos, as you talk about lichens. Review why they are important:

- They grow all over world and may be important, like trees, in the carbon dioxide-oxygen balance in the air we breathe.
- They are important as air pollution indicators.
- They sometimes help archaeologists in dating ruins. (Discuss how lichens grow and their rates of growth.)
- Some hummingbirds make nests with them.
- In other parts of the world, reindeer and monkeys eat them. Traditionally, some northern Native Americans ate them when other food supplies were low.
- Some are used as dyes.

4) Save about 35 minutes for the second part of this station, a scientific investigation concerning lichen growth in this area. Pass out clipboards, pencils, and back-to-back copies of the *Science Investigation Form* and *Data Collection Sheet: Do Lichens Like Sun or Shade*. Instruct students to work in pairs. Go over the steps of a scientific investigation, as needed. Have students write in the question: "Do more lichens grow on north-facing rocks or on south-facing rocks?" For their prediction/hypothesis, students should write whether they think there will be more, less, or the same amount growing on the north-facing rocks. Explain that *procedure* means the way in which they will conduct their experiment. Explain some factors of good procedure, including random selection of plots on their chosen rock faces and no altering of data to fit what they have predicted. Demonstrate a way of randomly selecting plots. Go over the data collection sheet. Take time to explain aspect,

and review compass directions. Demonstrate how to measure smallest and largest lichens and how to estimate percentages of cover by lichens. (Explain that the data sheet asks for more information than is needed to answer our particular question, but scientists often collect extra data because it can eventually lead to more interesting questions and hypotheses.) Have students fill out the procedural steps they will use.

5) Give students boundaries, and have them investigate as many plots as possible on one slope. When their time is half over, have them switch to the opposite-facing slope.

6) Gather students, and discuss their results. If the students haven't already figured this out, more lichens, and more types, grow on north aspects. Their conclusion might be related to *why* there are more lichens on north-facing slopes (i.e. lichens seem to thrive in moister, cooler locations). Tell students they have just completed a scientific experiment using all the elements of the scientific method. Are there other questions about lichens they could ask? Reemphasize the important roles of lichens.

EXTENSION

Have students "advertise" in a newspaper article the use of lichens in a new household product or a technological breakthrough. The advertisements must include basic lichen information and their important role in an ecosystem.

Studying lichens

SCIENCE INVESTIGATION FORM

Lichens up close

Scientists' Names: ____________________ Date: ____________________

QUESTION

PREDICTION OR HYPOTHESIS

PROCEDURE

List step by step.

RESULTS

What actually happened?

CONCLUSIONS

What did we learn or what do our results mean?

DATA COLLECTION SHEET

Do More Lichens Grow on North-Facing Slopes or South-Facing Slopes?

Plot#1

Aspect: ______________________________

# of Colors: ___________________________

Smallest: _____________________________

Largest: ______________________________

% of Coverage: ________________________

Plot#2

Aspect: ______________________________

# of Colors: ___________________________

Smallest: _____________________________

Largest: ______________________________

% of Coverage: ________________________

Plot#3

Aspect: ______________________________

# of Colors: ___________________________

Smallest: _____________________________

Largest: ______________________________

% of Coverage: ________________________

Plot#4

Aspect: ______________________________

# of Colors: ___________________________

Smallest: _____________________________

Largest: ______________________________

% of Coverage: ________________________

Plot#5

Aspect: ______________________________

# of Colors: ___________________________

Smallest: _____________________________

Largest: ______________________________

Plot#6

Aspect: ______________________________

# of Colors: ___________________________

Smallest: _____________________________

Largest: ______________________________

BACK-UP STATION

Cryptos Up Close

To be used in place of station #1 if potholes have dried up or are too muddy for observation; one hour.

Objectives

The students will be able to:

a. Identify cryptobiotic soil.
b. Name at least two functions or roles of cryptobiotic soil in the high desert ecosystem.
c. Explain the basic steps of the scientific process.
d. Measure and record cryptobiotic soil crust data.

Materials

Disturbed chunks of cryptobiotic crust for examining; microphotographs of cyanobacterial sheaths; hand lenses; microscope and slides; bottle of water; eye droppers; copies of *Science Investigation Form* and *Cryptobiotic Soil Data Collection Sheet* (back to back); rulers; pencils; clipboards; calculators; optional: polysaccharide sheath model.

Note

If possible, prepare a microscope slide showing cyanobacterial sheaths before the station begins.

PROCEDURE

1) Have students sit within a few feet of cryptobiotic soil. Tell them that they will look closely at the cryptos in a few minutes, but to first see if they can identify any variation in the cryptos from where they are sitting. Tell them that cryptobiotic soil crust is a community of organisms and there are slightly different organisms in the community from place to place. Explain, however, that all of the soil crust contains cyanobacteria sheaths. Use the polysaccharide sheath model and/or your fingers coming out of the end of a pulled-down long sleeve to demonstrate how the filaments come out of a sheath when the soil is moist. Show them real sheaths in a chunk of cryptos reserved for this purpose. These sheaths are what allow the crust to play such an important role in holding the soil together. Show them microphotographs of the sheaths.

2) Ask students to take turns looking through the microscope at a slide showing the sheaths, and when they're not at the microscope, to get on their bellies with hand lenses to look at live cryptos. Give boundaries and warnings about not crushing living cryptos. After a few minutes, gather the group, and briefly discuss some observations. Tell them about the other organisms that are part of cryptobiotic soil, particularly mosses and lichens.

3) Have students put water (using eyedroppers) on some mosses in the soil crusts. Watch, and note the changes. The mosses swell up, absorbing moisture, and turn bright green.

4) Tell students that there is another function of cryptobiotic soil that is impossible to see. Ask if any students have seen their parents add compost or fertilizer to plants. Explain that, like fertilizer, the lichens in cryptobiotic soil add nitrogen to the soil. Only a few kinds of plants add nitrogen (e.g. beans, alfalfa, cryptobiotic crusts), but nitrogen is essential for other plants to grow. Review the cryptos functions as a soil stabilizer and water absorber.

5) Explain to students that they are going to do a scientific investigation to answer a question about cryptobiotic soil in this area. Pass out clipboards with the *Science Investigation Form* and *Cryptobiotic Soil Data Collection Sheet* (back to back) and pencils. Students may work in pairs or on their own. Review the steps of the scientific process, as needed. Have them write the question that they will try to answer: "Is the cryptobiotic soil bumpier in one area than in another?" Show them the two areas that they'll be comparing, and have them make and write their prediction/hypothesis. Explain factors of good procedure, including random selection of which bumps they will measure and deciding how the bumps will be measured so that they are all measured in the same way. Demonstrate the random selection and the measuring technique. Go over the data collection sheet. Have them write in the steps of the procedure.

6) Help students get started with their measurements. When half of the data collection time is up, have them switch to the second area even if they haven't measured ten bumps yet. Save some time for them to figure out average bumpiness for each area. (Some will need help with this math.) Gather students, and have them fill out their results section and compare their results. Ask if the results were similar for different data collectors. Were their hypotheses supported by the data? Ask why they think the crust was taller in one area; the answer to this might go in their conclusions section. Discuss factors that might be relevant (i.e. crushing by footsteps, ORVs, bicycles, or even wildlife, drainage patterns, blown sand from a nearby wash or trail suffocating the crust, different types of substrate, steeper slope in one area).

EXTENSION

Have students write a story about a walk through

SCIENCE INVESTIGATION FORM

Cryptos up close

Scientists' Names: ____ Date: ________________________________

QUESTION

PREDICTION OR HYPOTHESIS

PROCEDURE

List step by step.

RESULTS

What actually happened?

CONCLUSIONS

What did we learn or what do our results mean?

CRYPTOBIOTIC SOIL DATA COLLECTION SHEET

Step One

Measure the height of several crypto bumps in two different areas, and record below:

Area One	Area Two
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

Step Two

Compute average bumpiness for each area.

Average = total measurements in area / number of measurements in area

AVERAGE BUMPINESS IN AREA ONE =

AVERAGE BUMPINESS IN AREA TWO =

Exploring Pothole Microorganisms

a crypto forest from an insect's perspective. This story should include interesting and correct information about high desert cryptobiotic soil.

Objectives

Students will be able to:

a. Make a slide, and use a microscope properly.

b. Explain the basic steps of the scientific process.

Materials

Microscopes; microscope slides; eyedroppers; water collected from a pothole; one sheet of paper per group; containers to set out the above items at each station; water and absorbent cloths for cleaning slides; extension cords and power bar as needed.

PROCEDURE

1) Briefly review the field trip. Ask students if they can name the first step of the scientific process. Write *question* on the board, and then write the question: "How many different types of microorganisms can we find in collected pothole water?" Ask for the next two steps of a scientific investigation, and write *hypothesis* and *procedure* on the board. Ask students to wait to make their hypothesis until you give them more information about the procedure (so that they can make a more educated hypothesis).

2) Demonstrate and write on the board (in abbreviated form) the procedural steps students will use in gathering data for this investigation:

a. Use an eyedropper to put one small drop of pothole water on a microscope slide. (Demonstrate and stress this drop should be smaller than a dime.)

b. Look at slide through microscope. Discuss how to tell if you are looking at a microorganism or just dust. It's very difficult to tell at times. Describe that most small sand or silt grains have rounded edges and sometimes broken edges that look like glass breaks. Tell students to look for movement, cells, hairs, or things that look like photos they've seen of microorganisms. This is also the time to demonstrate and explain how to use the microscope and how to handle it without damaging it. Ask students to show other group members anything they suspect of being a microorganism.

c. Make a group list of different organisms seen. The list can include the organism's name, if known, and/or a written description or drawing. Each group should have notes good enough to determine if another group's sighting is the same or different than their sightings. Explain that each group's list will be collected for review.

d. Clean slides. (Describe how.)

3) Now have students make hypotheses. Assign six groups to six microscope stations. Circulate among the groups at the microscopes.

4) After the procedures are completed, bring students back together and compare the lists of findings (results) of the different groups.

Discuss conclusions.

Potholes in the Needles District of Canyonlands National Park

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ANNA BRESEE

FIELD TRIP
Bighorn Sheep

Theme
Bighorn sheep require a specific habitat in order to survive and thrive.

Utah State Science Core Curriculum Topic
Standard Five: Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective One: Observe and summarize information about microorganisms.
Objective Two: Demonstrate the skills needed to plan and conduct an experiment to determine a microorganism's requirements in a specific environment.
Objective Three: Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

Field Trip Location
Any location where students can hike safely for several miles with a likelihood of seeing bighorn sheep. The Lower Porcupine Rim Trail from Highway 128 near Negro Bill Canyon is an excellent choice. This is a winter field trip.

Times
Pre and Post trip lesson are 45 minutes. During the hike each lesson is conducted with the entire class and takes 10-15 minutes.

Science Language Students Should Use
Algae, fungi, microorganism, decomposer, single–celled organism, bacteria, protozoan, producer, hypothesis, experiment, investigation, variable, control, culture

Background

(from Hauke, 1998; U.S. Forest Service, Rocky Mountain Region 1995)

Bighorn sheep are the most highly evolved and most widely distributed of all bovines. They are thought to have evolved in North Africa and migrated to the Americas during the Pleistocene. Desert bighorn sheep live in the Canyonlands of Utah and the deserts of Arizona, New Mexico, and some parts of California and northern Mexico. Desert bighorns are very sensitive to changes in the environment; therefore, they are often referred to as an "indicator species." A healthy, thriving herd of bighorns is indicative of a healthy, thriving ecosystem. An unhealthy herd of bighorns may indicate that the ecosystem is overused. Recent on-going studies by biologists indicate that for a herd of bighorns to survive long-term, there must be a minimum of 100 animals.

Bighorns are generally a medium gray-brown with white on the rump, backs of legs, and muzzle. This coloring allows them to blend in with the rocky landscape that surrounds their habitat. Desert bighorn depend primarily on their sense of sight to detect danger. They also have good hearing. Their sense of smell is used to distinguish between foods, detect enemies, and identify their young.

Adult desert bighorns are 30-39 inches tall at

Group at Mesa Arch

the shoulders. Males are normally larger than females. An adult male, called a ram, averages 160 to 200 pounds or more early in the summer. Rams have a thick, blocky appearance. They have thick necks and large curled horns that measure up to 30 to 40 inches along the outside of the curl. An adult female bighorn, called an ewe, averages 105 pounds. Ewes are more slender than males; they have especially slender necks. Ewes have small horns measuring 10 to 13 inches long. Wildlife managers categorize bighorns into four size classes, using the curl of the horn to determine the class. Rams recognize their elders by the size of their horns; dominant sheep having the biggest horns. Average life expectancy is 10-12 years.

Desert bighorns need food, water, escape terrain, and space. Their first food preference is Indian ricegrass. They also browse brush and plants with woody stems, especially blackbrush, and sometimes ephedra. They also feed on a few forbs (green leafy plants other than grasses). Water is the primary limiting factor for desert bighorn. Rams can go a long time without drinking; getting all the water they need from their food. But ewes, especially during lactation, require a regular source of water. Sources of water include streams, potholes, dew, springs, and water found in food. Desert bighorn prefer open space around their drinking holes so they can see approaching threats. They won't venture more than a few hundred meters from their escape terrain to get water.

Bighorns use escape terrain to get away from predators, since few animals are able to move as quickly as bighorns through such rugged terrain. Bighorns do not run long distances, but escape their enemies by climbing and hiding in this rugged terrain. Caves and the shelter of trees are used during poor weather and to escape aircraft and eagles. Predators of bighorns are coyotes (most common), eagles (feed on lambs), gray foxes, bobcats, and mountain lions. Predation is not a primary cause of death for bighorns, due to their escape terrain and the variety of wildlife that these predators prey upon.

The area across highway 191 from the Atlas Tailings pile has all the components of good desert bighorn sheep habitat. It has an open space for the animals to graze and spot predators, and it is close to steep rocky escape terrain. Unfortunately, cars hit approximately one sheep a year, a danger the sheep are not genetically adapted to avoid.

Ewes have their first lambs at about age three, and produce one, rarely two, lambs each year. Lambs are born in the spring and gain weight quickly. By two to three months of age they have sleek, well-proportioned bodies. At six months of age they are weaned from their mothers. Lambs are usually born in rough terrain with caves or overhanging rocks for protection from predators and weather. Nighttime bedding grounds are often near the top of ridges or long spurs, from which ewes can see much territory. Locations like this allow for a quick escape over the ridge or down the mountain.

Desert bighorns have a "nursery system." Two ewes remain with all of the lambs on the edge of escape terrain. The other ewes in the band move into open areas to feed on succulent spring plants. Lambs are obedient to the ewes in charge. The feeding ewes return to the lambs on occasion to nurse and exchange places with the nursery ewes. As lambs become older and begin to eat solid foods, they begin to travel with their mothers.

Cause of death can be hard to determine in bighorns. Causes include diseases caused by bacteria and viruses, parasites, tumors, and mineral and dietary deficiencies, as well as accidents, poisonous plants, and extreme climate conditions. Often several factors interact to cause death. Domestic sheep are the biggest threat to bighorn. They eat similar foods and carry parasites and diseases detrimental to bighorn. Bighorns are known for precipitous herd die-offs. Investigations have attributed the causes to parasites and diseases. Recent management efforts to separate domestic sheep from bighorn range have resulted in decreased die-off. Ear mites cause the most common disease among the bighorn of southeastern Utah. These mites spread down from the head, cause skin problems, and weaken the sheep, making them more likely to succumb to other stresses.

When settlers arrived in the western U.S., there were probably 1.5 to 2 million desert bighorns. In 1975, there were only about 1000 in the state of Utah. The drop can probably be attributed to diseases brought in by European domestic sheep. In the 1970s, grazing leases within Canyonlands and Arches national parks expired. Around this time, the BLM also ended sheep grazing leases on BLM lands near the bighorn range in the parks. Consequently, the populations of bighorn sheep in this area have vastly increased. When Canyonlands was established in 1964, there were 80 bighorn living in the park. Most bighorn were in the Island in the Sky District; a few were in the Needles District. Now, Island in the Sky is home to approximately 350 bighorn. Some Island in the Sky sheep were transplanted to produce the Arches herd, now 125 head, and the Maze herd, now 50-100 head. The population of the Needles herd dropped from 125 to 15 in the mid 1980s, after domestic sheep were grazed just outside the park. The domestic sheep were removed and the bighorn population has since rebounded to 50 head.

Individual bighorns can become physically run-down or nervous if harassed by other bighorns, large animals, or people, which can contribute to improper diet. Bighorns are sensitive to people on foot, especially in areas where people seldom travel. Bighorns seem less bothered by people on bikes or in cars, even when vehicles stop for a look.

Bighorns commonly use pathways dictated by the topography of the land. The Colorado and Green rivers provide natural barriers that divide herds, and prevent the spread of disease. Unfortunately, roadways, fences, and canals built by people tend to cross bighorn travel routes. This can limit movement from feeding grounds to water, causing herds to become isolated. Inbreeding can occur in smaller herds, which weakens the immunity and health of the herds and creates a serious concern for the herd's longevity. Fortunately, much of the land occupied by bighorn is under the protection of government agencies. These agencies are attempting to implement new regulations on bighorn range that will benefit these animals.

Bighorn sheep at Arches National Park

PRE-TRIP ACTIVITY
A Bighorn Adventure

Objectives
Students will be able to:
a. Describe the habitat of desert bighorn sheep.
b. Name some adaptations that help desert bighorn to survive.

Materials
"Ovisopoly" board game, with game pieces, cards, and dice; bighorn skull; bighorn and mule deer track casts and scat; bighorn pelt.

PROCEDURE

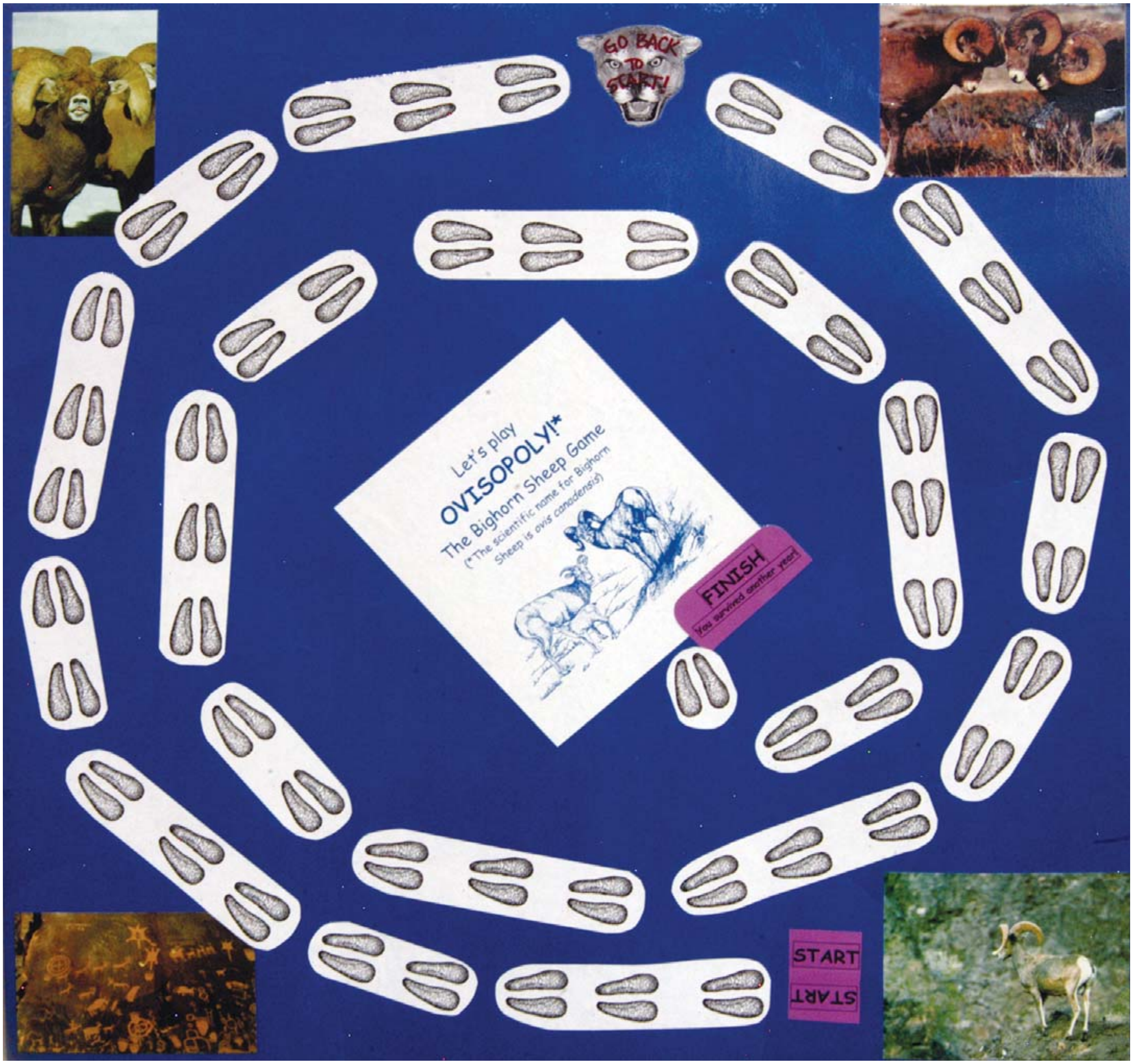
1) Tell the students that on their winter field trip, they are going to be learning about the habitat of one of the large animals that lives in Arches National Park and other places around Moab. Tell students that you will give clues as to the animal's identity, and when they think they know, they should raise their hands. Give clues until the whole class has raised their hands. Features such as brown fur, white butts, split hooves, and curved horns are good clues, as are adaptations such as diet, jumping and rock-climbing skills, and survival activities. You can use a riddle, such as, "I live in a desert garden, I can go for a week without water, and I regularly survive head-on collisions. Who am I? "

2) Tell the students that they are going to be playing a board game about the survival of the bighorn sheep. Give instructions and divide the class into groups of four. Stress that they must read the cards aloud to the other players! Circulate among the 4 groups and discuss objects such as a bighorn skull and bighorn and mule deer track casts and scat samples as the students are playing the game, and make sure they're reading the cards aloud.

3) Tell the students that the upcoming field trip will involve a fairly strenuous hike and that they need to be prepared to hike uphill. Explain that the trail may be snow-packed in places, so it is very important that all students wear shoes with good traction. Review appropriate behavior when near steep drop-offs. Emphasize the importance of bringing the right clothes, including layers, hat, mittens, and warm socks. Tell students that a thermos with hot soup or a hot beverage for lunch will help to keep them warm. Encourage students that own binoculars to bring them.

Following tracks at the tracking station

Ovisopoly Game Board



Ovisopoly Game Cards - Ewes

It's fall and you find a mate

Move ahead 2 tracks.

You find a big pothole filled with water from a recent rainstorm.

Move ahead 2 spaces.

You are 3 years old and this spring you give birth to your first lamb, a 9 pound female.

Move ahead 4 tracks.

Your ears become infested with mites. As a result, you cannot hear a cougar stalking you and are unable to get away in time.

Go back 5 tracks.

You and the other ewes in your family group find good places to forage for food for the summer.

Move ahead 3 tracks.

Your excellent eyesight allows you to see a human coming from almost a mile away. You climb the rocky slope until you feel safe.

Move ahead 2 tracks.

Ovisopoly Game Cards - Ewes

You are alarmed by a loud noise below you. You find your lamb and lead him to a safe place.

Move ahead 1 track.

Five new houses are built in your territory. Loss of space makes you stressed and you become sick.

Go back 2 tracks.

After a week without water, you find a big pothole to drink from.

Move ahead 2 spaces.

You find shelter in a cave so your lamb will be safe from a golden eagle flying overhead.

Move ahead 3 tracks.

You become nervous and highstrung because of many humans and cars in your range. You and your group are forced move to another area.

Go back 1 track.

A sheep farmer lets his herd of domesticated sheep into your territory. Many of your herd catch diseases and your population crashes!

Move back 5 tracks.

Ovisopoly Game Cards - Ewes

You run into a biologist's net and you are caught! Humans move you by helicopter to another territory and you begin a new herd where bighorns once lived.

Move ahead 4 spaces.

After domesticated sheep are moved out of your territory, the population of your herd grows from 20 to 200 in ten years.

Move ahead 5 spaces.

Biologists catch you in a net, place a radio collar around your neck, and release you. They can now track your location and learn about your habits.

Move ahead 1 space.

Ovisopoly Game Cards - Rams

You catch a disease from domesticated sheep and become too weak to live through the winter.

Go back to start.

A biologist catches you in a net and puts a radio collar on you so she can learn more about bighorn health and behavior.

Move ahead 2 spaces.

You find good food sources and by early summer weigh almost 200 pounds!

Move ahead 3 spaces.

During the fall rut (mating time) you butt horns with another ram until he gives up in exhaustion, so you have your choice of mates.

Move ahead 5 spaces.

You and several other bighorn sheep are transported by helicopter to a National Park where you begin a new herd in a protected habitat.

Move ahead 4 spaces.

You lose a head-butting contest and will not mate this year.

Go back 3 spaces.

Ovisopoly Game Cards - Rams

A poacher shoots you illegally for your magnificent horns.

Go back to start.

You outrun a cougar who's chasing you across a rocky hillside at 30 miles per hour!

Move ahead 3 spaces.

In captivity, you learn to shake nuts from an almond tree by butting it with your head!

Move ahead 2 spaces.

A two-year drought makes it hard for you to find enough food. You a forced to move for a better habitat.

Move ahead 1 space.

Frightened by a predator, you run blindly and fall off a cliff, breaking your leg.

Go back 4 spaces.

You spend the cool evening playing with other lambs, leaping and scampering around on the cliffs.

Move ahead 2 spaces.

Ovisopoly Game Cards - Rams

Wildlife managers install a "guzzler", (which is like a water fountain for bighorn sheep) in your territory, so you and your lamb have enough water to drink all summer.

Move ahead 4 spaces.

One hunting permit for a bighorn ram is auctioned off for $55,000 this year! This pays for wildlife experts to study and manage your herd for the whole year.

Move ahead 4 spaces.

By counting the rings on your massive horns, a biologist can tell that you are 20 years old, which is very old for a bighorn sheep.

Move ahead 3 spaces.

Fewer deer this year mean that cougars prey on your herd more than usual, so your population drops.

Go back 3 spaces.

Hike the Habitat: Bighorn Sheep, Plants, Tracks and Birds

Objectives

Students will be able to:

a. Describe the habitat of desert bighorn sheep.
b. Name two plants that desert bighorns eat.
c. Name two other creatures that share the habitat of desert bighorn sheep.

Materials

Binoculars; *Track Pattern Cards,* each with a description and drawings of one basic track pattern, laminated construction paper "tracks", at least two copies of *Animal Tracks of the Southwest* (Stall 1990) or other tracking field guides; *"Who Am I?"* plant riddles; small poster with the anatomy of a bird on one side and the names of seven birds to be discussed on the other; pictures of seven commonly-seen birds; bright clothing for human bird dress-up; bird field guide; maps of area.

Note

If the sheep are grazing along the highway, stop the bus and spend some time reviewing bighorn characteristics, adaptations, and difficulties.

PROCEDURE

1) Tell the students that we will be starting on a strenuous hike. Remind them of safety concerns on steep slopes and potentially icy or snowy trails, distribute warm clothes, and confirm that everyone has drinking water. Explain that there will be an instructor at the beginning and at the end of the line of hikers, and that it's ok to spread out. However, we will stop at a number of stations and wait for everyone. Explain that each station will involve a short talk or activity relating to bighorn sheep and the things that share their habitat. Ask them to think about what they know about bighorn sheep and about where they might be likely to see them.

2) **Bighorn Review Station (This information can be covered on the bus if bighorns are viewed from the bus.):** Ask the students what they remember about bighorn sheep from the pre-trip. Discuss topics not mentioned, such as water needs, lifespan, predators, management issues, bighorn rehabilitation and relocation, migration routes and barriers, and herd size. Discuss likely areas to see sheep on this hike. Go over what to look for, including movement and color. Demonstrate the use of binoculars, including focusing and finding the spot they want to look at.

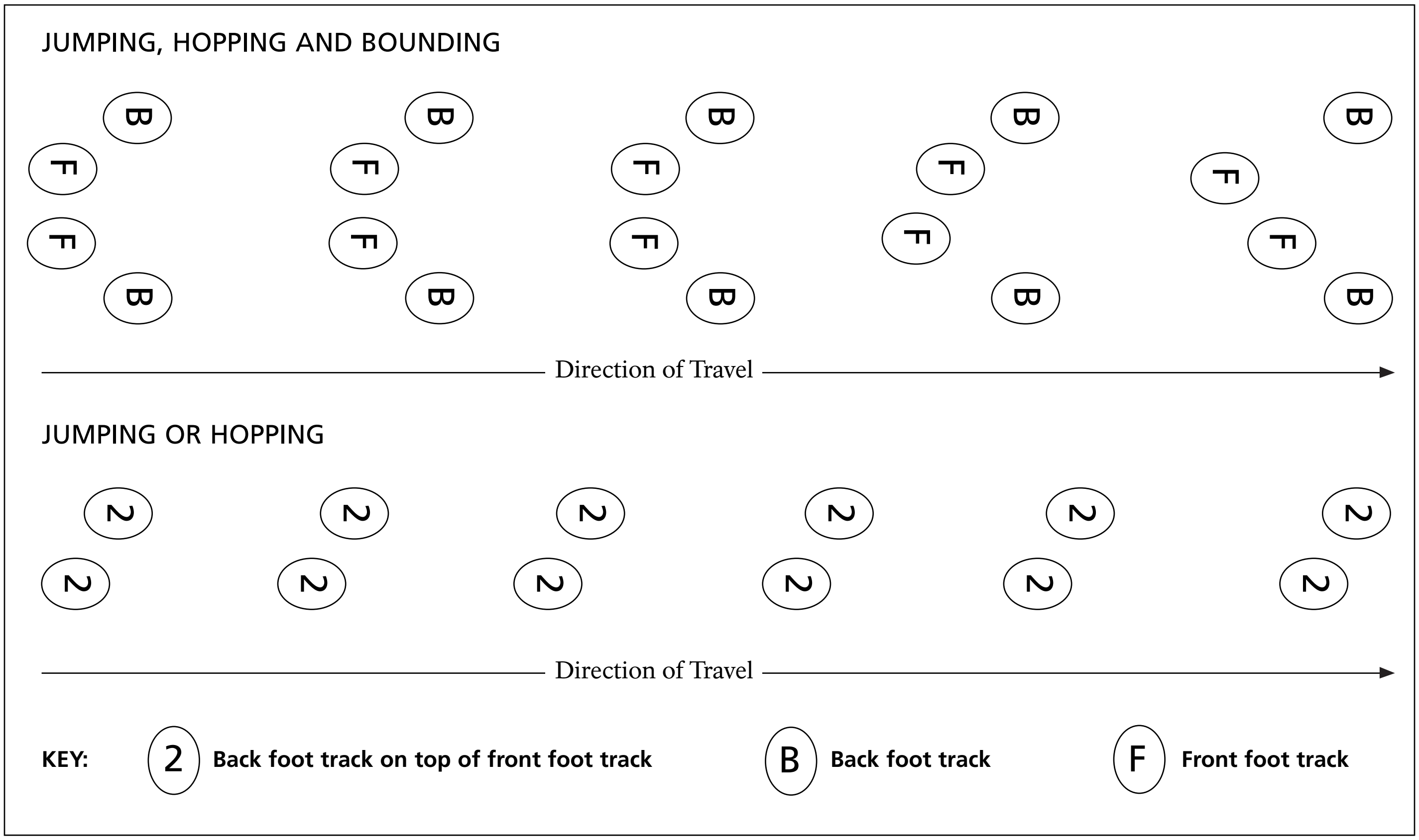
Challenge Question: Why do wildlife management officials have to spend large amounts of money to move bighorn sheep?

3) **Tracking Station:** Introduce tracking, and include the following information: Though seeing many animals out during the day is uncommon, seeing tracks is easy. The sands common in southeastern Utah often show tracks in astonishing detail. Looking at tracks can tell you what sorts of animals were in an area, as well as how they were moving. Sometimes, tracks tell you what the animals were doing and if they were interacting with each other. You may examine the track itself, including its size and shape, whether a hoof made it or how many pads the foot had, and whether there are claw marks or fur imprints. How far apart tracks occur can often give you an idea of an animal's size. Habitat should be kept in mind, as it gives clues to the animals likely to be in an area. Tell students that another aspect of tracking is looking at patterns, as they reflect how different animals move. Ask students to list ways animals move (e.g., walk, hop, jump, slither). Tell students that the ways that four-legged animals move can be classified into a few basic types. Have a volunteer student read the paragraph from one of the three **Track Pattern Cards.** Use rocks or cardboard tracks to replicate the pattern. Explain and/or demonstrate how the animal moved, and, if appropriate, have a few students try to replicate the movement. Repeat for the other two **Track Pattern Cards.** Discuss how to recognize snake, bird, and lizard tracks. Insect tracks can often be seen in sand; they might hop or walk. On the next part of the hike, ask students to look for different types of patterns, and see if they can find one of the patterns on very different scales. It's important to remind them not to step on tracks or others won't be able to see them!

Challenge: Find a walking or hopping track pattern, and be the first to show it to an instructor. Perhaps assign a different pattern to each instructor. Hint: Your chances are better if you hike near an instructor.

4) **Lunch and Plant Station:** Ask the students if any of them recognize the plants along the trail. Point out or show pictures, and tell a little about eight plants they might see: Ricegrass, Blackbrush, Dwarf Mountain Mahogany, Pinyon, Juniper, Rabbitbrush, Sagebrush and

Track Pattern Cards

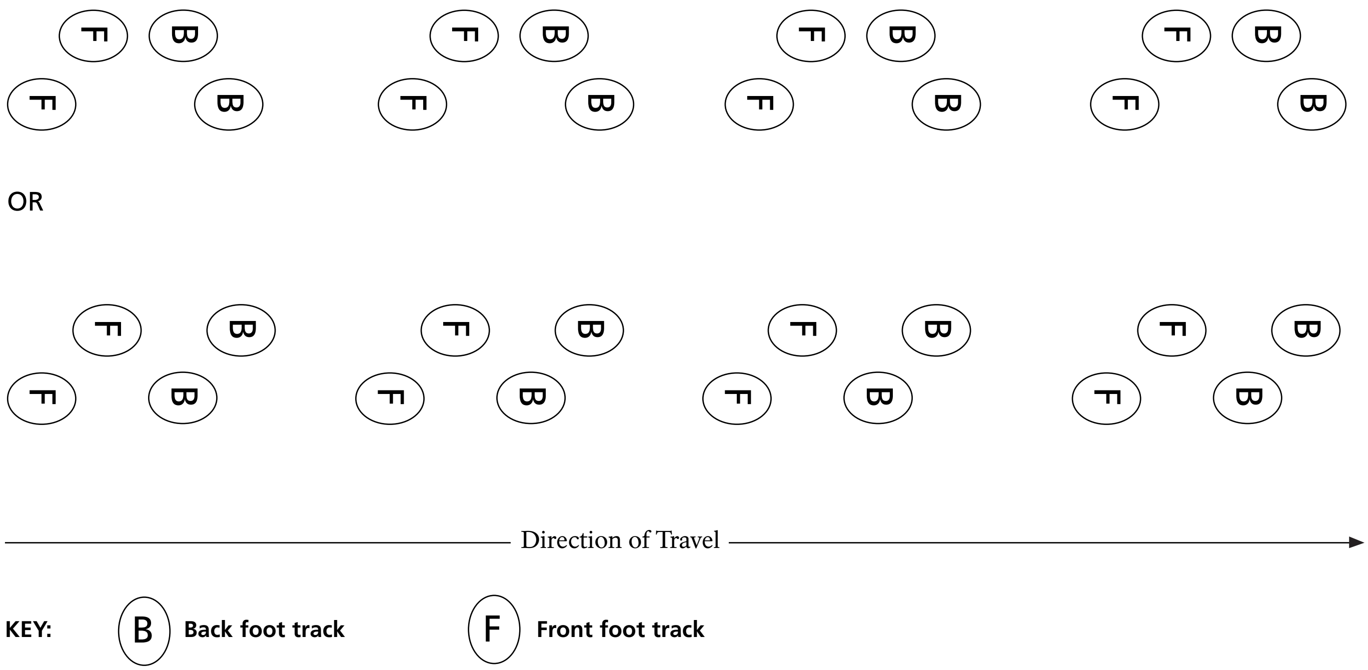


Many animals hop or jump occasionally. Rabbits, squirrels and some mice move this way most of the time. Their back legs and feet have more muscle for pushing off, and are wider apart than their front feet. Their back feet land one beside the other. Their two front feet may land beside each other, or one may land before the other one.

When weasels jump, their back feet land in their front feet tracks. This type of jumping is called bounding.

Track Pattern Cards

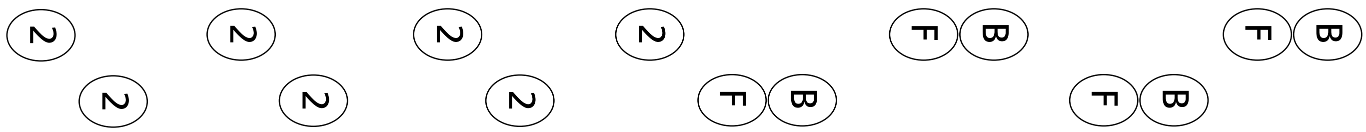
GALLOPING



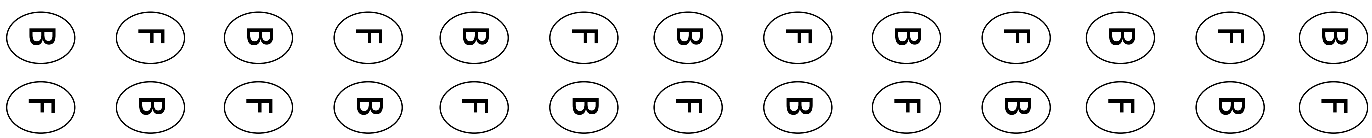
Horses gallop when they want to get somewhere fast. So do deer, antelope, dogs, cats and even bear. There are two different orders in which animals move their feet when they gallop. In both cases, their back feet give the biggest push and land in front of their front feet.

Track Pattern Cards

WALKING, SPEEDING UP TO TROTTING



WADDLING



Direction of Travel →

KEY: 2 **Back foot track on top of front foot track** B **Back foot track** F **Front foot track**

Most land animals can walk and, if they want to go a little faster, trot. Deer, elk, dogs, cats and some mice move this way most of the time. Slower, heavier, low-to-the-ground animals like porcupines and raccoons have a walking pattern called waddling.

Mormon Tea. Tell students that you will read a series of **"Who am I?" Plant Riddles** about the plants we just discussed. Ask them to raise their hand when they know the answer. After reading each riddle, pick a student to name the plant and see if they can point it out.

Challenge: Find and point out a piñon tree.

5) Bird Station (at the trailhead if there is time): Using the bird poster, introduce birdwatching and the anatomy of a bird. (One instructor should dress up like a bird in a hidden nearby location during this introduction.) The human bird should appear briefly on cue, imitating a bird behavior, such as tail bobbing. Once hidden, ask students what field marks they noticed. Ask them if they noticed any distinctive behavior that might help us to identify the bird. Have the human bird reappear for a little while longer this time. Once again, discuss field marks and behavior. Introduce seven birds that might be seen at this location in the winter, including golden and bald eagles, peregrine falcons, common ravens, mallard ducks, Canada geese, and dark-eyed juncos. Show photographs of each. Tell students about the Audubon Christmas Bird Count, and describe the area that is counted around Moab each year (Moab, all of Spanish Valley, Sand Flats, Castle Valley, the wetlands, along the river, Mill Creek, Behind the Rocks).

Challenge Question: Have students raise hands to guess which of the seven birds was most common in the latest Christmas Bird Count. (Christmas Bird Count numbers for December 16, 2000 are: 827 juncos, 170 mallard ducks, 167 ravens, 15 Canada geese, 10 golden eagles, 1 peregrine falcon. No bald eagles were seen in this year's count, though they are seen most years.)

Studying animal tracks

"WHO AM I?" PLANT RIDDLES

- I send up fresh green shoots in patches of cryptobiotic soil every spring,
- But I turn brown by late summer.
- Ancestors of Native Americans collected my tiny seeds for food.
- I am a favorite food of desert bighorn sheep living near Moab.

Who am I? Indian Ricegrass.

- I have small gray-green leaves, which prevent moisture loss in the hot summer.
- My thick woody branches are opposite each other.
- I am another favorite food of bighorn sheep.
- I have yellow flowers in the spring.
- I get my name because my stems look black in the rain.

Who am I? Blackbrush.

- I grow largest and thickest in disturbed areas, and I can be five to seven feet tall.
- My bright yellow flowers can be used to make golden dye for cloth.
- Rabbits and other small critters hide under my branches to escape predators.
- Often I am covered with insect galls that look like cotton balls.

Who am I? Rabbitbrush.

- I survive in the desert by photosynthesizing in my stems instead of in leaves.
- Desert bighorns eat me.
- I look like an upside-down broom.
- Early pioneers used to make tea from my stems.
- The drug Sudafed comes from my cousin.

Who am I? Mormon Tea.

- I have small dark green leaves with a waxy coating to prevent water loss.
- My leaves occasionally look rusty.
- I have tiny pink flowers in the spring.
- My woody branches are alternate.
- From a distance, I am often mistaken for blackbrush.

Who am I? (Dwarf or Curlleaf) Mountain Mahogany.

- I am a tree, and can live 300 - 500 years.
- I am one of the most common evergreen trees in Canyon Country
- My short needles grow in twos.
- My pitch is used by some Native Americans to waterproof baskets and pots.
- My nuts are tasty and full of protein, but only grow abundantly every 3 to 7 years.

Who am I? Pinyon Pine.

- My leaves have waxy scales and my bark peels off in long strips.
- I am another common evergreen tree of Canyon Country.
- Humans can use my blue berries for flavoring or tea.
- I can live to be 300 - 500 years old.

Who am I? Juniper.

POST-TRIP ACTIVITY
Murder Ewe Wrote

(adapted from U.S. Forest Service, Rocky Mountain Region, 189-195)

Objectives
Students will:
a. Analyze information about a complicated wildlife population event, and apply the analysis to answering a number of questions.
b. Name three factors that can lead to a crash in a bighorn sheep population.

Materials
Six each of: *Mystery Story* and *Mystery Questions* (copied back-to-back), clues, and hint cards.

PROCEDURE

1) Ask students to share information about bighorn sheep they learned during the field trip, and supplement. Tell the students that the biology and life history of any wildlife species, and how it interacts in its ecosystem, is incredibly complex.

2) Explain that wildlife biologists and land managers attempt to understand these complexities, but often learn the most from what might be considered disasters, such as big die-offs in a population. Explain that you have a story about an apparently mysterious die-off in a herd of Rocky Mountain bighorn sheep. (Though fictional, this story is a compilation of several real-life events.) Explain that desert bighorns face some similar challenges and some different ones. Ask students to listen carefully, as they will be working in groups and solving the mystery later. Read the *Mystery Story* as a class.

3) Tell the students that to solve this mystery, they will need to answer a number of questions. Read the *Mystery Questions* to the class. Explain that each group will have a copy of the story and questions, as well as five clues to help them answer the questions.

4) Divide students into groups of about four, and instruct that one student in each group needs to have a pencil and paper in order to record the answers to the questions. (This duty may rotate.) Explain that the answers to questions 1-9 are found either in the story or in one of the clues. Explain that question 10 requires putting together all of the information. Tell them not to attempt this question until they have finished answering the others. Tell students that each group will get one hint card, which may be traded in for the location of the answer to one question. Suggest that if they are stuck on a question, they skip it and move on to the next one, using the hint card as a last resort. Explain that they may find the answer they are looking for later or may come across a harder question. Pass out a set of *Mystery Story/Mystery Questions*, clues, and a hint card to each group. Give the students enough time so that most groups finish with questions 1-9.

5) Call on different groups to present their answers. As a class, discuss the answer to question #10. Review the steps wildlife managers took once they finally figured out the causes of the die-off, and discuss what steps they could take in the future to prevent or limit similar events. Discuss differing challenges of the desert bighorn sheep near Moab.

MYSTERY STORY OF THE TAYLOR CANYON ROCKY MOUNTAIN BIGHORN SHEEP HERD

(from U.S. Forest Service, Rocky Mountain Region, 192)

The Taylor Canyon bighorn sheep herd lives in a typical Rocky Mountain ecosystem characterized by rugged mountains, canyons, and small, grassy valleys. Valley bottoms are privately owned; most of the other higher terrain is public land.

During the summer months, wildlife biologists estimated the bighorn sheep herd to number 250. This was the largest herd size in many years. Numerous ewes with lambs were sighted in alpine meadows and scattered bands of rams were noted at higher elevations.

Late-season (December) elk hunters in the area reported lots of bighorns. All appeared healthy, although there seemed to be few lambs. Many male rams were observed fighting other male rams for females with whom to mate.

January brought heavy snows and cold weather. Snow depths were up to five feet and mid-day temperatures were as low as −20 degrees (F).

On January 18, wildlife biologists noted ski tourists pulled off the highway taking pictures of the bighorn sheep. One tourist came within ten feet of a ram. Bitter cold and deep snows persisted.

Ranchers noted that many of the bighorns appeared to be tired, ragged, and weak. The bighorns staggered and mucous discharge was observed coming from their mouths and noses. Many bighorns were coughing. On January 21, one rancher notified wildlife officials.

Two days later, wildlife officers found eight dead rams and two extremely sick ewes. Two dead bighorns were sent to a university lab where autopsies were performed to determine the cause of death.

On February 5, ground surveys and aerial flyovers found only 48 bighorn sheep alive. Some of the remaining bighorn sheep were netted and medically treated. Food was brought in. No more deaths occurred.

What caused this dramatic population crash?

MYSTERY QUESTIONS

(adapted from U.S. Forest Service, Rocky Mountain Region, 192)

1. How many Taylor Canyon bighorn sheep died between the summer and February 5th?

2. What unusual wildlife behavior could have been a clue that the sheep were not healthy?

3. Why did so many of the herd die in such a short period of time (January through February 5th)?

4. Why did the rams die earlier than the ewes?

5. Why were there only a few lambs in December, though there were many in the summer?

6. How do bighorn sheep get lungworms? What is the lifecycle of the lungworm?

7. What is the relationship between the pneumonia bacteria and the lungworm?

8. What human activities increased winter crowding and decreased winter food supplies for the Taylor Canyon bighorn sheep herd?

9. What conditions make it more likely that a bighorn sheep will get sick with pneumonia/ lungworm?

10. Name as many factors as you can that caused the die-off of the Taylor Canyon herd.

MYSTERY CLUES

(adapted from U.S. Forest Service, Rocky Mountain Region, 193-195)

A. Usually only unhealthy wild animals allow humans to get close to them.

B. Young or physically stressed bighorn sheep are more likely to get diseases than healthy unstressed sheep. Stresses may include a difficult winter, loss of habitat, fighting for mates or running from machines. Stressful conditions will kill off young sheep first, and an observer might notice a lack of lambs in a band.

C. Diseases spread easily among sheep herds in crowded conditions. In wintertime bighorns tend to be more crowded than in summer. During summer, bighorn sheep stay at high elevations on public lands, eating nutritious alpine plants. When winter snows arrive, they typically move down into the valleys and canyons, where there are more private lands, more people, and more cattle. Private lands in Taylor Canyon are grazed in the summer by large numbers of cattle, leaving fewer plants for the bighorn. During this summer one rancher sold some of his valley land to a developer, who has begun building homes. By the time winter arrived there were fewer places to graze, with less food available on them.

D. Bighorn sheep, like people, can't fight off diseases as well when they are tired. Several factors caused the Taylor Canyon bighorns to use up extra energy and become tired this fall and winter:

*Their breeding season is November and December. Rams fight to breed with ewes. Because of the energy spent on fighting, rams have less energy leftover for a long, hard winter than ewes do.

*The elk hunters in December were riding snowmobiles. These loud machines easily spook bighorn, causing them to use up energy getting away.

*During cold weather, bighorn sheep spend lots of energy trying to stay warm. In mid-January temperatures were −20 at midday.

*When the ground is covered with snow, bighorns must paw through the snow to find grass to eat. This is tiring. Five feet of snow were on the ground in January.

*Deep snow makes walking more tiring for bighorns. It also makes bighorn herds congregate closer together, on a few pieces of bare ground or areas with the least snow. When animals are closer together, disease is more likely to spread throughout the heard.

E. Autopsies of Taylor Canyon bighorn sheep showed that dead bighorns carried both pneumonia-causing bacteria and parasites called lungworms. Even healthy bighorn sheep have the bacteria. But the bacteria only cause disease when there are open sores in the lungs. Lungworms cause these open sores in the lungs.

The larval stage of the lungworm is found in small land snails that bighorns sometimes eat by accident when grazing. The larval stage of the lungworm then travels from the bighorn's stomach to its lungs, and causes the open sores. Once in the lungs, the lungworms mate and lay eggs. The pneumonia bacteria takes hold in the sores, and cause the bighorn's lungs to fill up with mucous. The bighorn tries to cough the mucous out. When the lungworm eggs hatch, the young larvae are coughed up and swallowed, leading to more sores and mucous in the lungs.

ANSWERS FOUND IN CORRESPONDING LOCATIONS

1: story	2: A	3. D	4. D	5. B	6. E
7. E	8. C	9. B, C, D	10. Story and all clues		

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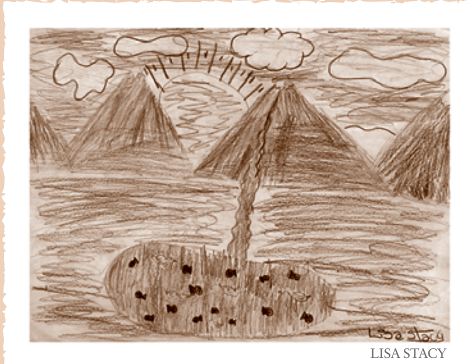
Kroger
Sunscreen
15 spf
SUNSCREEN LOTION
with
Aloe & Vitamin E
Very
Water
Resistant
10 FL OZ (295ml)
NATIONAL
PARK
SERVICE



LISA STACY

FIELD TRIP

Heat, Light and Sound

Theme
The properties of heat, light, and sound can be readily observed in the natural environment.

Utah State Science Core Curriculum Topic
Standard Six: Students will understand properties and behavior of heat, light, and sound.
- **Objective One:** Investigate the movement of heat between objects by conduction, convection, and radiation.
- **Objective Two:** Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.
- **Objective Three:** Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

Field Trip Location
Any riparian corridor with a perennial stream. As long as at least some of the area is surrounded by natural habitat. Suggested areas include, Courthouse Wash in Arches National Park; Mill Creek Canyon near Moab; or Negro Bill Canyon along Highway 128 near Moab.

Times
Pre and post trip lessons and Field trip stations are 30 minutes each.

Science Language Students Should Use
Angle of incidence, angle of reflection, absorption, conduction, conductor, convection, medium, pitch, prism, radiation, reflection, refraction, spectrum, vibration

Background

Energy is transported around the universe in the form of waves. Sound waves, light waves, ocean waves, heat waves, and radio waves are some examples. The shape of the wave determines its characteristics. The *amplitude* is the height of the wave. The *crest* is the top of the wave. The *trough* is the bottom of the wave. *Frequency* is the number of times the wave crests in a given period. *Wavelength* is the distance between two crests. The *speed* of the wave is determined by multiplying the frequency times its wavelength. If the crest on one wave occurs at the same time and place as a trough in another wave they are considered *out of phase*. These waves can interfere with each other or even cancel each other out.

Sound travels in waves. Sound is created by the vibrations or the back and forth movement of objects. When an object vibrates, it sends sound waves off in all directions. However, sounds waves can only travel through mediums such as air, water, and objects. In other words, sound cannot travel in a vacuum. Sound waves travel at different speeds trough different mediums. The denser the material, the faster the wave travels. *Pitch* is the highness or lowness of a sound as we hear it. High-pitched sounds have a high frequency, and low-pitched sounds have a low frequency. Humans and animals communicate, or express their thoughts, by vibrating their vocal cords. Thicker cords vibrate more slowly and have a lower pitch. Similarly, the thicker strings on stringed instruments vibrate more slowly and produce deeper pitched tones. As boys get older, their vocal cords thicken and their voice drops. The intensity or the amplitude of the sound wave determines loudness.

Students learn how sunscreen can protect them from UV radiation

The sun emits electromagnetic radiation in the form of waves. This radiation travels out from the sun in straight lines in all directions. A small portion of this radiation reaches the earth. We see small portions of this radiation as visible light. Television signals, radio waves, X-rays, Ultraviolet rays, microwaves, and infrared radiation have wavelengths that are either too short or too long for us to see. Upon encountering an object, light waves can be reflected, refracted, or absorbed. When light is reflected, it is bent. The angle at which the light is reflected depends on the shape of the surface it is reflected from and the angle at which the light strikes the surface. Many objects that appear to produce light are only reflecting the light of another object. When light travels through a transparent object, it is bent or refracted. The shape of the object determines how the light is bent. Prisms, and sometimes water drops, bend light so that the different wavelengths are separated. Lenses bend light so that objects appear larger or smaller depending on the shape of the lens. Humans have created many different types of lenses that help us to explore and understand the world around us (Atwater et al, 1993).

Another way we perceive radiant energy is in the form of heat. Heat moves from one object to another by conduction, convection, or radiation. *Conduction* is the transfer of heat from one substance to another by direct contact. When either fast or slow moving particles touch one another, energy is transferred. Slow moving particles speed up, and fast moving particles slow down. *Convection* is the circulation of heat within liquids or gasses. Heating substances causes convection. When the particles begin to move faster, they get lighter and rise, allowing space for denser, cooler substances to fall. *Radiation* is the transfer of heat through open space in the form of waves. All warm objects emit heat waves or radiate (Utah State Office of Education, 2002).

Searching for birds during the "Sounds of Spring" activity

PRET-TRIP ACTIVITY

What is a Wave?

Objectives
Students will be able to:
a. Describe the characteristics of a wave.
b. Name three types of waves.

Materials
Slinky; four balloons; stereo; laser pointer; prism; mirror; black paper

PROCEDURE

1) Tell the students that they are going to be studying waves. Ask students to name as many types of waves as they can think of, and list these on the board. Make sure to include sound waves, light waves, and heat waves. Tell students that waves transfer energy from one place to another. Briefly describe, or ask students to describe, how each wave listed on the board transfers energy.

2) Tell students that the characteristics of a wave are determined by its shape. Ask for two volunteers to help you demonstrate. Give each student an end of a slinky and ask him or her to stand four to six feet apart. Have one person make one movement up and down. Discuss the wave and the motion, or direction, of the wave. Describe the properties of the wave (using the slinky for demonstrations and drawing on the board as necessary). Cover the terms *amplitude*, *crest*, *trough*, *frequency*, and *wavelength*. Have both students move the slinky and discuss the effects of wave interference.

3) Ask for four different volunteers. Give each volunteer a balloon and ask him or her to hold the balloon between his or her hands. Tell them that you are going to produce a wave and that you want to see if they can detect it with their balloon. Play a bit of music. Ask the students to describe feeling the wave. Ask the other students if they detected the wave. Discuss how the eardrums detect the vibrations of sound waves just like the balloons do. Tell students that deaf people sometimes are able to enjoy music by using balloons. Explain that sound travels trough different substances differently. Have four different volunteers hold the balloons and listen to music. Then have them put the balloons next to their ears. Have them describe the difference in the sound waves.

4) Tell students that light waves always travel in a straight line. Use a laser pointer to demonstrate. When light encounters an object, it can be bent, absorbed, or reflected. Have the students help you demonstrate by holding a prism, a piece of black paper, and a mirror. Ask students if anyone can tell you why we see color. Describe the combination of light reflection and absorption. Tell the students that radiant heat is another wave that we can detect with our bodies. Ask students to name sources of radiant heat. Discuss how different objects absorb heat at different rates. Ask the students to name some ways we can measure this absorbed heat.

5) Discuss what students need to bring on the upcoming field trip.

STATION #1

Whose Got the Heat?

Objectives

Students will be able to:

a. Name two characteristics of substances that absorb heat.

b. Describe why water can change the temperature of an object.

Materials

Surface thermometers; cups; clipboards; pencils; *Science Investigation Form* and *Heat Absorption Data Sheets*

PROCEDURE

1) Ask students to name a source of heat in the natural world. Discuss with students the path the sun's energy takes to get to the earth. Describe how much of that energy actually reaches our planet. Tell the students that heat from the sun travels through space in the form of waves. This is called radiant heat. Ask the students what happens to that energy once it arrives. Explain that some of it is reflected and that the objects on the earth absorb some of it. Objects that absorb heat then slowly transfer that heat through either conduction, convection, or radiation.

2) Tell the students that you are going to do an experiment to discover what objects absorb the most heat. Divide students into pairs. Give each pair a clipboard, pencil, thermometer, and *Science Investigation Form* and *Heat Absorption Data Sheets*. Have students begin to fill out their *Science Investigation Sheet* by writing down the question, "What objects radiate the most heat?" Explain the procedures, and show students how to aim their thermometer on objects, and then record their data. Have students list some possible locations for each of the given categories. Give students specific boundaries, and ask them to fill out their *Heat Absorption Data Sheets*.

3) Have students circle on their paper the three hottest objects they measure. Have each group present their top three objects and compare the temperatures. Have students name these objects in the "results" section of their investigation form. Discuss the properties of these objects, and have students write in the "conclusions" sections why the properties or locations of the objects made them radiate more heat. Have students pick the lowest temperature object they found in the sun, and discuss the properties of this object. Why did it not absorb as much heat as the other objects?

4) Ask the students what they like to do on a hot day. Explain that heat always moves to objects or areas that are cooler. When you swim you are giving your heat to the water through conduction. Pick two of the hottest objects you found. Take the temperature of the object, and pour water on it. Take the temperature again, and compare the results with the students. Explain that the water rapidly absorbs the heat, causing the temperature to fall. Ask students why the riparian corridor they are in is cooler, than other areas than the summer.

EXTENSION

In the hot sun, place a wooden bowl, a white plate, an iron pan, a plastic plate, some cotton cloth, and some lettuce leaves. On each of the surfaces, crack open an egg. Check on the eggs every five minutes until one of the eggs has fried.

Recording the temperatures of different surfaces

SCIENCE INVESTIGATION FORM

Whose Got the Heat?

Scientists' Names: ______________________________ Date: ______________________

QUESTION

PREDICTION OR HYPOTHESIS

PROCEDURE

List step by step.

RESULTS

What actually happened?

CONCLUSIONS

What did we learn or what do our results mean?

HEAT ABSORPTION DATA SHEET

CATEGORY	OBJECT DESCRIPTION	TEMPERATURE
Something Brown		
In the sun	______________________	______________________
In the shade	______________________	______________________
Something White		
In the sun	______________________	______________________
In the shade	______________________	______________________
Something Green		
In the sun	______________________	______________________
In the shade	______________________	______________________
Something Hard		
In the sun	______________________	______________________
In the shade	______________________	______________________
Something Soft		
In the sun	______________________	______________________
In the shade	______________________	______________________
Something Wet		
In the sun	______________________	______________________
In the shade	______________________	______________________

STATION #2

The Sounds of Spring

Objectives

Students will be able to:

a. Identify at least one wetlands bird.
b. Name two reasons for a bird to sing.
c. Describe what determines the pitch of a birdcall.

Materials

International Migratory Bird Day poster (National Audubon Society and the U.S. Fish and Wildlife Service Division of Wildlife Refuges 1998); bird information and photo cards; a few copies of *Arches National Park Bird* checklists; binoculars; bird field guide; birdsong identiflyer with accompanying sound cards; a variety of bird calls

PROCEDURE

1) Discuss riparian areas as a resting area for migratory birds, using the *International Migratory Bird Day* poster as a prop. Ask students to name some reasons that birds migrate. Discuss the value of the Colorado River and its tributaries as a resting area on the Rocky Mountain Flyway. Ask students how birders might know a bird is near. Explain that sometimes a bird cannot be seen, but it can be heard. Ask students to name some reasons a bird might sing: call for mate, alert others to danger, tell others the location of food, for pleasure, check in with the flock, etc. Tell students that in all animals the pitch of the song or voice is determined by the size of the animal's vocal chords. For example, boys' voices change when heir vocal cords get thicker. Explain that birds have a syrinx instead of a larynx and that its size determines the pitch of the bird's song. Play a variety of birdcalls, and ask the students to predict which ones will be highest or lowest in pitch.

2) Show students the Arches National Park bird checklist, and explain how to extract information from it. Hand out a bird card to each student, and have each find his bird on the wetlands checklist. Give students a few minutes to prepare presentations: each will read his or her bird's name, show its picture, tell how abundant it is in each season, and read an interesting fact about the bird from the bird card. Have the student predict what the call of their bird might sound like. Play the call on the identiflyer, and discuss how the call differed from the student's prediction.

3) Review the properties of sound. Sound travels in waves. If we can figure out which direction the sound wave is coming from, it might help us to find the bird that is making it. Tell students that many things can absorb sound waves before they reach the ears of another bird, human or animal. Discuss what in the riparian area might absorb the sounds a bird makes. Ask students which calls would more likely be heard at a farther distance.

4) Pass out binoculars, and show students how to use them. Preface the bird walk with the need for no talking and quiet walking. Remind students that they are much more likely to hear birds than see them. Tell the students they are to keep track of how many different birdcalls they hear. Have students share their discoveries by pointing to birds, frogs, nests, or other things that they hear or see. Return to the spot where you started the station, and collect binoculars.

5) Ask students how many different calls they heard. Ask students why they were more likely to hear birds this time of day than they were to see them. Review the reasons that birds sing.

EXTENSION

Have students record bird songs in the same area for several days in a row. Students should chart how often particular calls were heard on each day. Compare to charts made by other students in other location. Have students hypothesize why different birds were heard at different locations.

STATION #3

UV or Not UV?

(adapted from Twiest &Twiest)

Objectives

Students will be able to:
a. define UV radiation
b. name three ways it affects humans
c. list three ways to protect themselves from getting too much UV

Materials

UV sensitive beads in cassette tape cases inside a covered box; extra tape cases; sunscreens of various SPF numbers *(no more than 2 years old)*; old sunscreen; science investigation sheets; UV posters (2); prism; permanent marker; clipboards; pencils, string, water, rags, scissors.

PROCEDURE

1) Tell the students they are going to be discussing UV radiation. Have them think back to their fifth grade field trip at the Island in the Sky and relate what they remember about UV radiation and the ozone layer. Remind students that UV radiation comes from the sun. Use a prism and the small poster to demonstrate how we can see different wavelengths of light when it is refracted and show students where UV falls into the spectrum, next to violet just out of our visual range. Since the wavelength of UV radiation is shorter than violet it has higher energy and thus has a greater effect on living organisms than other wavelengths of light. Living things are adapted to a certain amount of UV, and indeed it is necessary for life. But excessive UV radiation causes sunburn, eye damage, immune system suppression, and greater risk of skin cancer in humans. Because of depletion of the stratospheric ozone layer, scientists have been closely monitoring UV radiation since the 1990's.

2) Ask students how they protect themselves from getting too much UV, using the "Protect Yourself" side of the UV poster to illustrate. They can avoid UV by staying inside during the midday hours (10am-4pm), since it is greatest when the sun is the most direct. They can wear clothing that absorbs UV radiation before it reaches the skin like: wide-brimmed hats, long sleeves and pants, and sunglasses. Or they can put on sunscreen to reflect and absorb some of the UV radiation that reaches their skin.

3) Ask students if they have ever wondered how sunscreens work. Discuss what is meant by SPF. Sun Protection Factor numbers give an idea of how long your skin will be protected from burning. For ex., an SPF of 30 *may* give you 30 times longer in the sun without getting burned than if you hadn't put any sunscreen on, depending on your skin type and how much sunscreen you have applied. Ask students to figure out how long could you stay out in the sun with a sunscreen of SPF 30 if the UV index says you would get burned in 5 minutes without sunscreen,. Remind students that our bodies metabolize sunscreen every 2-3 hours. Discuss what that means for your skin if you forget to reapply, or do not apply enough sunscreen.

4) Tell students they are going to conduct an experiment to find out how well different sunscreens work using: UV beads, plastic cases, and sunscreens of different SPF's. Demonstrate how the UV sensitive beads change color when exposed to sunlight, then change back when taken out of sunlight. Work with the group to come up with a question and procedure for their experiment. Divide the students into pairs, giving each pair an experiment form to fill out in complete sentences. If students are having a difficult time, suggest the question "Which sunscreen reflects the most UV radiation?" A suggested procedure would include some variation of smearing the different tape cases of beads with different sunscreens, and then exposing them to the light. Tape cases should be marked, and there should be a control case with no sunscreen on it. Students may want to place a case in the shade, in the reflection of a water source, etc. Record data, and write conclusions. Have the students present their questions, procedures and results to the rest of the group.

Note

Keep the beads from the first group in the sunlight and discuss how the results have changed over the course of the day.

5) Review the definition and concerns about UV radiation. Have students stand so they can see their shadows. If their shadows are longer than their heights, they are receiving minimal UV. If the shadows are the same height or shorter than the person, as in midday, they should be protecting themselves from excessive UV radiation.

EXTENSION

Let students make bracelets for themselves using the string and 5 or 6 beads.

SCIENCE INVESTIGATION FORM

UV or Not UV?

Scientists' Names: ____ Date: _______________________________

QUESTION

PREDICTION OR HYPOTHESIS

PROCEDURE

List step by step.

RESULTS

What actually happened?

CONCLUSIONS

What did we learn or what do our results mean?

STATION #4
Uses of Lenses

Objectives
Students will be able to:
a. Explain why humans would want to bend light.
b. Name three objects humans have created out of lenses.
c. Describe how one object with a lens works.

Materials
Bending Light poster; *Inside an Object* cards; seven objects with lenses(*corresponding to the inside an object cards*); clipboards; *Scavenger Hunt Sheets*; pencils; spoon; extra lenses; extra microscope; extra hand lenses; extra binoculars.

PROCEDURE

1) Point to an object in the distance, and ask the students to describe it. Ask them if there is a way for us to describe it in more detail without moving. Discuss why humans invented binoculars and telescopes and how these devices have aided the exploration of our world and universe. Next, pick up a single sand grain, and ask the students to describe it. Again, ask them if there is a way to describe it in more detail. Discuss why humans invented magnifying glasses and microscopes and how these devices have aided in our understanding of our world. Using the *Bending Light* poster and the spoon, explain that all these devices are possible because light bends when it passes through glass. The curvature of the glass determines how it bends, making an object look bigger or smaller. The lenses on our eyes do the same thing. Someone whose eyesight is not perfect has lenses that are either too flat or too curved. Have students name some other objects that humans have created to bend light: glasses, camera lenses, etc.

2) Give each student an object and an accompanying *Inside an Object* card. Have the students read the cards, study the pictures, and examine the object. Tell the students that you are going to give them a few minutes to figure out their objects and then explain it to the group. Give students 5-10 minutes to prepare their presentations. Answer individual questions as the students are working. Have the students each present their information to the group.

3) Divide the students into pairs. Tell them that they are going to go on a scavenger hunt. By using the lenses they have been discussing, they will be able to find everything on their lists without leaving the area. Hand out clipboards, *Scavenger Hunt Sheets*, and pencils. Instruct students to write down what they saw and what object they used to find it next to each category.

4) Have students turn in their pencils and lenses. Ask each pair to describe one of the things they found and how they found it.

EXTENSION

Tell students to pretend they are alone on a desert island with only a magnifying glass. Give students one minute to write down all the uses they can for the magnifying glass. Have each student write a short story telling how the use of the magnifying glass saved his or her life.

Exploring how lenses bend light

SCAVENGER HUNT

Use lenses to follow the directions in each box

Name: ______________________________

Draw a living thing smaller than an eraser. What type of lens did you use to see details?	Draw the veins of a cottonwood leaf. What type of lens did you use to see details?
Locate a bird's home. Write a sentence describing its location. What type of lens did you use to find it?	What makes sandstone sparkle? What type of lens did you use to see details?
What shape is a sand grain? List five characteristics that make it different from the others. What type of lens did you use to see details?	Are there any petroglyphs in the area? If so draw them. What type of lens did you use to search?
Describe the legs of an insect. Draw what you see. What type of lens did you use to see details?	Can you spot any wild animals in the area? If so describe them. What type of lens did you use to search?

POST-TRIP
Can We Get Too Much?

Objectives
Students will be able to:
a. Name four instances where too much heat, light, or sound was harmful to humans.
b. Name two instances where too much heat, light, or sound was harmful to animals.

Materials
Too Much? cards; paper; pencils

PROCEDURE

1) Review the field trip with students. Discuss the properties of heat, light, and sound. Tell students that throughout history humans have produced their own heat, light, and sound. Often, the results are good. Ask students to point out some instances of artificial heat, light, or sound used in the classroom to help them learn. Explain that sometimes, however, artificial heat, light, and sound can cause harm. Sometimes, it is just too much of a good thing that has detrimental effects.

2) Divide students into groups of four. Each group needs to have a piece of paper numbered one through sixteen. Give each group a packet of *Too much?* cards. Tell the students that each card describes a situation where humans are producing heat, light, or sound. One person needs to read each card, and the group should discuss the situation. A different person should write down (next to the corresponding number) whether the situation will: cause harm to humans, annoy humans but not harm them, do only good for humans, cause harm to animals, bother animals but not harm them, do nothing to animals. Students should take turns reading and writing.

3) As a class, discuss the answers to each of the dilemmas. Discuss how some of the situations are good for humans but harmful to animals. Sometimes, humans do not even realize that what we are doing has unintended consequences. Discuss some instances where the value to humans might out way the harm caused to animals.

TOO MUCH? CARDS

1. Your neighbor leaves his car stereo on full blast. The sound is so great that it shakes your windows.

2. The army uses sound to map the ocean floor.

3. You use sonar to find fish in the lake.

4. A city is lit up by streetlights at night.

5. There is always a radio or a television on in your home, but the volume is turned on low.

6. You use a chainsaw to cut firewood.

7. Spotlights light up an object throughout the night.

8. You hear fifteen different airplanes while you hike in a local national park.

9. Semi-trucks speed near your neighborhood going 55 miles an hour.

10. Two students are talking in class during a silent reading period.

11. A mother sings softly to her baby.

12. A large parking lot is covered with blacktop; there are no trees.

13. Campers build a large campfire under a tree.

14. A home is heated throughout the winter using a woodstove.

15. You and your friends spend an entire night shinning your flashlight on sleeping creatures.

16. You help a friend produce a fireworks display on the Forth of July.

References and Resources

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"What is UV?" and "Ultraviolet Radiation" (E.C. Weatherhead)
http://www.srrb.noaa.gov/UV/what.html.

Ultraviolet Radiation Fact Sheet
http://earthobservatory.nasa.gov/Library/UVB/uvb_radiation3.html

Choose Your Cover Skin Cancer Prevention Campaign
http://www.epa.gov/chooseyourcover/qanda.htm

SunWise Kids
http://www.epa.gov/sunwise/kids/kids_uvindexPrint.html

National Park Service
U.S. Department of the Interior

National Park Service
Canyon Country Outdoor Education
2282 SW Resource Blvd.
Moab, UT 84532